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AUTHOR Lesnak, Richard J.
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ABSTRACT

Basic algebra at Robert Morris College (RMC) in Pittsburgh, Pennsylvania, is a remedial course for students with virtually no algebra background, and for students whose previous experiences with algebra have created math blocks and math anxiety. A study was conducted in an effort to measure quantitatively the benefits of using linguistic methods in the teaching of basic algebra. A control group of 52 students were taught with the same methods and techniques that the instructor had been using for more than 25 years, while an experimental group of 52 students were taught with a course design that incorporated writing-to-learn and speaking strategies. Students in the experimental group were instructed that for any problem involving more than one step, an order of operations had to be followed. Students were required to write and talk about this step-by-step precedure. Before each test, students had to submit step-by-step written procedures for each kind of problem they were to encounter on the test. The instructor separated students' pre-test writing into two groups: those steps written perfectly or nearly so, and all others. Test scores showed marked parallels to the clarity of pre-test writing. When students were informed of the correlation between their pre-test writing and test performance, they grew increasingly enthusiastic about writing throughout the remainder of the course. The control group completed the course with a mean average of 74.5%, while the experimental group averaged 77.7%. In written course evaluations, all 52 experimental subjects were positive about the usefulness of the writing assignments, including the 8 students who did not pass the course. (PAA)

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Mr. Richard J. Lesnak

Professor, Quantitative and Natural Sciences
Robert Morris College, Pittsburgh, Pennsylvania

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When the Robert Morris College writing-across-the-curriculum program was proposed, I had been teaching mathematics for over 25 years with what I considered to be a great deal of success. At that time I was only cautiously optimistic that linguistics, writing-to-learn strategies and speaking in particular, would improve the learning process in my math classes. Could these strategies create more positive student attitudes? I am no longer a skeptic. I have no doubt that writing and speaking activities can be a valuable tool not only in improving academic achievement but in eliminating the negative attitudes with respect to mathematics in general, developmental math and remedial algebra in particular.

Basic algebra at Robert Morris is a remedial course for students with virtually no algebra background and for students whose previous experiences with algebra have created negative attitudes and virtually no confidence in their abilities to learn algebra. Using terminology I am not particularly fond of, many students sincerely believe they have "math blocks" and suffer from "math anxiety." Thus, I concentrated my efforts in developing and using writing and speaking strategies to promote attitudinal change as well as to strengthen basic algebraic computational skills.

The ability of an instructor to use linguistic activities in a classroom with confidence and competence depends upon the skill with which the teacher incorporates these activities into a course design. A cross-sectional chart referred to as a Henderson matrix is very useful in analyzing course objectives, methods to achieve these objectives, and the writing-to-learn and speaking techniques to be incorporated into these methods. In a basic algebra course the cognitive objectives involving knowledge of facts and computational skills are too often uppermost in the teacher's mind. Increased confidence and improved attitudes must be given proper attention. The failure to define and attack these affective objectives results in mediocre course designs and teaching.

My statistics background influenced my decision to design an experiment in which I could quantitatively measure the benefits of using linguistics as a tool in the teaching of basic algebra. It was during implementation and final evaluation that I realized qualitative benefits involving changes in attitudes, confidence levels, and self-images might be taking place. These qualitative findings will be discussed later. Fifty-two students were taught using the same methods and techniques I had been using for more than 25 years (the control group). Fifty-two other students (the experimental group) were taught using a teaching syllabus prepared from the course design incorporating writing-to-learn and speaking strategies. My goal with this experimental design was to statistically compare the final mean average for the control group versus that of the experimental group.

The students' initial reactions were discouraging to say the least. The writing and speaking classes were not only unimpressed with the plan, they were depressed and discouraged to the point of hostility. To quote the typical student, "I've never been able to learn algebra the regular way, now you're making things worse by making me also worry about writing and speaking." It was at this point I realized I had to sell the plan to the students before I could hope to be successful. My "sales pitch" focused on three points. First, I was not going to teach them to write or speak nor was I going to evaluate their grammar. I was going to use writing and speaking to help them overcome the "math blocks" they perceived themselves as having. Second, the methods they had used in the past must not have worked very well or they wouldn't be in a remedial algebra class as college freshmen. Finally, my personal enthusiasm for the program had to convince them to give my theory a chance.

The first topic I discuss in a basic algebra course is the fact that there is an order of operations that must be followed in any problem involving more than one step. What better way to incorporate this order of operations into problem-solving techniques than by <u>writing</u> and <u>talking</u> themselves through the step-by-step procedure? What better way to understand what is making the problem difficult and how to get over the "block," than to be able to refer back to this written step-by-step procedure? Whenever students in my experimental classes failed to properly use the order of operations or hit one of their "blocks," they were expected to use their written procedures not only to find their mistakes but to also verbalize the correct procedures to be followed. The actual writing and verbalizing of step-by-step procedures

and the referring back to these procedures was the only difference in my teaching methods in the control (non-writing and speaking) and experimental (writing and speaking) classes.

One of my writing tasks turned out to be very effective, much more so than expected. Before the first exam I informed the students that a "ticket" would be required for admission to the exam. This "ticket" was to be a list of the written procedures for each of the different kinds of problems I announced were to appear on the test. The "ticket" would not be graded or evaluated in any way, but must be turned in at the beginning of the exam period in order to sit for the exam. Were there grumblings? Yes, but everyone turned in a ticket; they had no choice! Some students had the procedures written perfectly, some not so perfectly, some downright carelessly, some awfully. I separated the "tickets" into two categories. In group A were those that were written perfectly or nearly so, the others were included in group B. After I graded the exams, I found that <u>every</u> student who scored from 80% to 100% had turned in a ticket that was in group A and <u>every</u> student who scored less than 80% had a ticket in group B. I presented the class with this documented evidence. They were impressed. How impressed? A few weeks later I announced the second exam and the topics to appear on the exam. I deliberately said nothing about the ticket. Almost in unison, the class responded, "What about a ticket?" They were asking me to force them to write and verbalize the correct procedures. It was at this point that I became totally confident that linguistic activities could be a valuable weapon in the attack on the "math blocks" many of them perceived themselves to have.

Throughout the remainder of the semester the students in the writing and speaking classes continued to grow more enthusiastic and confident with their assignments. However, they felt there remained one "math block" to be challenged. How could writing help them with the dreaded word problems? Students feel "insiders" can read a problem and come up with the algebraic equation, while they, as "outsiders," do not have the intellectual skills to do so. In the experimental classes I illustrated that the desired algebraic equation is easily obtained once a statement of equality is written and verbalized in words. Very few remedial algebra students realize that the key to solving a word problem is the written statement of equality. I insisted they search out and write this statement of equality before attempting to write the algebraic equation. Most students felt this exercise gave them a chance at successfully solving word problems, something they never thought was possible.

The results of this experiment using linguistic activities in basic algebra are both quantitative and qualitative in form. The control group, those not exposed to the writing and speaking activities completed the course with a mean average of 74.5%. The experimental group, those who were taught using the writing-to-learn and speaking activities, averaged 77.7%. Even though these results were statistically significant, I prefer to downplay these statistical results. Educators, administrators in particular, tend to be obsessed with quantitative statistical documentation to the extent that qualitative research is discouraged.

I believe the qualitative results of my experiment are far more significant than a favorable statistical analysis. The final writing assignment in which the 52 students were asked to evaluate the course and the linguistic activities provided positive indications of success beyond all expectations. All 52 responses were positive! The grumblings that had bordered on hostility were totally gone. The 52 students included eight students who did not pass the course, but still felt that these activities helped them. A sampling of comments is presented in figure 1.

These qualitative results were much more important to me than the statistical data that indicated an increase in academic achievement due to the linguistic activities. I am absolutely positive that 52 students felt these activities not only helped their academic skills but also raised their levels of confidence and created more positive attitudes toward the learning of algebra. I would have been just as enthusiastic with the results even if the statistical analysis had not indicated a significant increase in academic achievement. I believe that students with the most severe "math blocks" are the ones that disassociate mathematical reasoning most completely from verbal reasoning. Establishing a bridge between the two is often enough to dissolve the "block." Linguistic activities certainly appeared to be that bridge for the students involved in this experiment. The qualitative results provided me with the most rewarding experiences of my 25 years of teaching basic and remedial courses; I know I achieved success in helping students attack their "math blocks" and reduce their "math anxiety."

Since I conducted this controlled experiment, I have discovered that linguistic activities are not only valuable in teaching developmental math courses, but are extremely beneficial in all my classes, including college algebra, calculus and statistics. Any time students respond with an answer to a problem, they must verbally interpret the computation with respect to the context of the problem. I have also found that writing can be extremely helpful to a student in preparing for a test in any math class. In all my classes the students are permitted to bring to any test an 8-1/2 by 11 sheet of paper with anything they wish to write on it ... so long as there are no numbers or examples ... only words! Most of my students tell me that the preparation of this "cheat sheet" is the best way they have ever encountered to study for an exam. They tell me that once they prepare this sheet they feel much more confident going into the exam. They tell me that this process most definitely helps to relieve their "test anxiety."

A final word of warning. Not all teachers will be able to achieve the same degree of success incorporating and using linguistic activities in their math classes. These activities will not work in a pure lecture-type classroom. The instructor must "sell" the learning process to his class. Especially in a remedial situation the students must be motivated by the enthusiasm of the instructor. Perhaps you say that elementary algebra is dull ... dull but necessary. I disagree. If a subject is dull, it is either unnecessary or it is badly taught. The use of linguistic activities can make a good mathematics teacher better; it cannot make a bad mathematics teacher good.